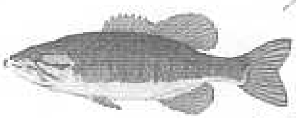
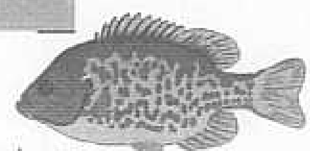
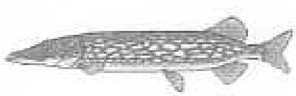


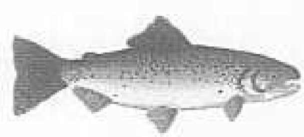


Freshwater Fish Inventory
Northeast National Parks, 1999-2001
2003 Narrative
Saint Gaudens NHS

Dr. Martha E. Mather
(413) 545-4895
mather@forwild.umass.edu

Alicia J. Norris
(413) 545-0128
anorris@forwild.umass.edu





Michael P. Carey
(413) 545-0128
mpcarey@forwild.umass.edu

St. Gaudens National Historic Site

Background Information

Relationship between this 2003 narrative and the previous 2002 summary. Herein, we review and interpret the detailed data collected in the freshwater fish inventory. The original report, distributed to all NPS personnel related to this project in April 2002, was written in three volumes: (1) Freshwater Fish Inventory for Northeast National Parks Final Report, 1999-2001, hereafter referred to as the "2002 Original Final Report"; (2) Freshwater Fish Inventory for Northeast National Parks Fish Key, 1999-2001 (hereafter referred to as the "2002 Fish Key"); and (3) Freshwater Fish Inventory for Northeast National Parks Appendix, 1999-2001 (hereafter referred to as the "2002 Appendix"). The details and data presented in the present narrative report, hereafter referred to as "2003 Narrative," are the same as reported previously in the 2002 reports with the addition of some requested corrections. This present narrative report was written to be more readable and thus is greatly simplified. For more details on any of the data trends reviewed here, the reader can consult the 2002 Original Final Report. In order that this 2003 Narrative be compatible with the 2002 Original Final Report, all trends reviewed here are referenced both in this 2003 Narrative and in the 2002 Original Final Report.

Overview. This park-specific narrative report has six parts. First, we review the objectives of the study. It is important to note that the larger freshwater fish project had three components: (a) an inventory of fish in northeastern parks, i.e., an assessment of what fish were present at each park/site; (b) research at the Cape Cod National Seashore to help understand one type of aquatic system, kettle ponds, i.e., a conceptual model of how things work; and (c) recommendations for a future monitoring protocol. The results of the inventory (component a) is presented as a biological summary of the freshwater fish found in each resource in a park-specific format. The results of the research related to understanding how the kettle ponds at Cape Cod National Seashore function (component b) is relatively complex and included only in the Cape Cod National Seashore narrative report. Recommendations for future monitoring protocols (component c) are made in each report and are the same for each park. Because our team thought carefully about the best sampling plan before the inventory (component a), we recommend that the sampling methods described for the inventory (component a) be continued in future monitoring efforts (component c). Thus, the recommendations for a future monitoring protocol (component c) are combined with the sampling method section in the inventory (component a).

After we state our specific objectives, in the second part of this narrative, we comment on philosophical considerations for setting goals for inventory and monitoring. We think this is important because, to be effective, park natural resource managers need to be active participants in setting and modifying the goals for natural resource monitoring. In addition, we comment on some general considerations in designing an effective fish sampling methodology. Third, we review the combined sampling methods that we used for the freshwater fish inventory and the protocols that we recommend for future monitoring. Because the methods we used are exactly what we recommend for the future, we combine these two sections. To change methods to protocols, the word "were" can be replaced with "should be." The fourth section of the present report reviews and interprets the results of fish sampling in a narrative form. In this section, we also comment on how the information in this narrative report relates to previous records on fish sampling. Next, potential anthopogenic impacts are reviewed. In this section, we describe human activities that could affect aquatic systems, detail how these activities impact fish, and review ways that these, typically adverse, activities can be anticipated and documented. Major management issues affecting each park are also reviewed and we point out specific threats to each surveyed park.

Sixth, we make recommendations for future activities related to conserving natural resources at the northeastern national parks.

Objectives

Relative to the inventory and monitoring components of the project, our objectives were as follows. First, we compiled existing information on past activities and surveys that relate to freshwater fish in each park (Original proposal objectives 1-2, April 1997, p. 4). Because previous fish data were very limited, often non-existent, we review and interpret this information at the same time we review and interpret the results of our sampling. Our next objective relative to inventory and monitoring was to determine the composition of fish communities in all major habitats (Original proposal objective 3, April 1997, p. 4). To determine the composition of the freshwater fish community, our specific goals were to (a) identify responses of interest, i.e., presence/absence, species diversity, species richness, relative abundance, and size structure); (b) qualitatively map aquatic habitats at each site based on the fish species that might occur and possible sampling gear; and (c) sample multiple sites of all representative habitats at each monitoring site (2002 Original Final Report, p. 49). In this sampling, we (d) sought to collect and identify 90% or more of all species, kept some samples for reference, counted and identified all species caught, and took select sub-samples of length information (2002 Original Final Report, p. 49, Specific Objectives 1-4). It is important to note that the above-mentioned reference samples were taken to help us in our field sampling. These representative samples were not part of the original proposal and were never intended to be comprehensive voucher specimens. Also comprehensive size relationships were not part of the original proposal so fish lengths were only taken on select, usually the most common, species. In addition, we sought (e) to link species to habitat types, i.e., keep records of where each species was caught, and (f) to identify potential anthropogenic effects, (i.e., historical management strategies, visitation, water degradation, land use, riparian condition, stocking, fishing pressure, flow modification, beaver, deer; (2002 Original Final Report, p. 49, Specific objectives 4, 5, 7). We also test, evaluate, and recommend appropriate protocols for future monitoring (2002 Final Report, p. 49, Specific objective 6; Original Proposal, April 1997, p. 4, #6). Objectives 4-5 from the original proposal (#4 sample select resources across season, assess trophic structure/functional ecology; #5 analyze these data to construct a conceptual functional model of how things work; Original proposal objectives 4-5, April 1997, p. 4) were undertaken only at select times and only in the Cape Cod National Seashore kettle ponds. These results are only included in the Cape Cod National Seashore report.

Philosophy of Monitoring

General goals. First, we review philosophical considerations relative to inventory and monitoring to emphasize the unique organizational, institutional and park-specific considerations in setting goals for what constitutes a "desirable" natural system. Establishing a workable and ideologically sound goal is essential to resource conservation through monitoring. Several goals may be appropriate for monitoring including: (1) maintaining present conditions; (2) restoring past conditions; (3) anticipating adverse human impacts; (4) some optimal biological endpoint; or (5) some optimal sociological endpoint (2003 Narrative Figure 1). The first step in maintaining present conditions, the first possible goal for monitoring, is to establish what resources are present through inventory then manage land and water resources in a way that maintains these conditions.

Restoration. Relative to the second possible goal for monitoring, to restore past conditions, we first need to establish some known previous condition or some desirable historical/natural reference. Some philosophical difficulties exist for establishing a unique natural or historical reference point. Specifically, because natural systems change through time, many possible reference times exist for a desirable natural community. These might include: (a) when the fish species evolved, (b) after the last glacier, (c) before Columbus, (d) when the park was chartered, or (e) some other equally justifiable time period. All of these are possibilities. An additional problem for establishing a historical reference is that human impacts, especially development, have changed our natural systems dramatically from these historic reference times. So restoring systems to these desired historical reference points may no longer be possible. In addition, in many of the northeastern historical sites, human historical and cultural events are a critical part of the park mission. Thus, we need to accept that humans and human impacts are a part of the natural landscape and incorporate the role and impact of humans into any goals for restoration. Another specific endpoint related to restoring a system is returning the system to some previous better condition. For example, managers might want to restore heritage fish such as native anadromous fish. Unfortunately, we often don't know what the system looked like when these fish thrived. Furthermore, sometimes the physical system has changed too much to support this historic community. For example, dams and other flow modifications have dramatically changed the entire system, in and out of the parks, since most anadromous fish were abundant. So relative to setting restoration goals that use a historical reference, we must address three philosophical questions: (1) Which view of nature and which historical reference are we trying to restore and maintain?; (2) Why?; (3) What is the role of humans in these systems? A fourth possible goal of inventory and monitoring is to anticipate and prevent future adverse human impacts. For example, if we know that land use, stream channel, or other adverse human impacts will occur, we can watch for specific adverse effects on the aquatic community.

Biological Endpoints. A fifth common philosophical goal for monitoring is to seek to achieve some optimal biological endpoint. Biological goals proposed in the past include (a) being a good steward; (b) promoting optimal ecosystem health and function; (c) understanding how the biological system works; (d) maintaining or restoring native species; (e) eliminating non-native species; as well as (f) academic concepts such as maintaining diversity, complexity, stability, resilience, and ecosystem health (2003 Narrative Figure 2). Although, conceptually all of these biological endpoints make sense, there are some operational issues that need to be resolved before they can be effectively applied. For example, is native vs non-native/introduced the best criteria by which to judge a healthy functioning community? (Note: we use non-native and introduced interchangeably.) Specifically, the northeastern US has a limited native fish community and 35% of freshwater fish in Massachusetts are introduced or non-native. This number includes a large number of the fish species that the public, especially recreational anglers, find desirable (2003 Narrative Figure 3). Many of these non-native or introduced fish have been in these systems for decades, have stable populations, and are naturally reproducing. Certainly, some non-natives, typically referred to as invading species, have adverse effects on other species. However, especially for fish, non-natives cause trouble only in select systems. Hence, it might be better to define a species desirability based on its impact or function in the system rather than whether it originated in the regional species pool. Complexity and diversity are often cited as biological goals because we assume that high diversity and complexity are related to increased stability and reduced invasibility. But more research is needed to document these links. Furthermore, although maintaining stability, resilience, and seeking to restore ecosystem health and biological integrity are useful philosophical goals for monitoring, more specific definitions are needed to operationalize what a functioning, restored system with biological integrity looks like. Finally, restoring and maintaining a system with natural reproduction although not always cited as a philosophical goal for biological monitoring is a measurable endpoint.

Social goals. Finally, optimal social conditions should be considered as endpoints for successful and effective management. Specific manifestations of this goal include a natural system that will (a) satisfy residents, the public, or other groups; (b) avoid lawsuits, bad press, etc; (c) result in positive public interaction/meetings; (d) balance traditional social considerations for resource management; or (e) help us understand how the social realm works. Perhaps the best goal for inventory and monitoring is some optimal system and society dependent bio-social goal . Establishing this requires that managers, biologists, and administrators think strategically and operationally about (1) What do the managers and the public want from each park/site?; (2) What biological communities are there now?; (3) Are these communities changing?; (4) Why?; and (5) What management actions should be taken?

How to start or immediate approach. Clearly establishing bio-social goals for any resource will require time and additional biological and social research. In the meantime, though, important actions can be taken immediately. First, we can determine what fish resources we have by using a representative, standardized, repetitive unit of effort to document the present community (2003 Narrative Figure 4, issue 1; data in this report). In addition, we can assess how things are changing in the future by planning to use the same representative, standardized, repetitive unit of effort through time. We can also start to study "representative systems" in depth to understand how things work so that we can generalize insights from them to other systems. Finally, in the immediate future, we can anticipate changes with *a priori* hypotheses of human impacts (2003 Narrative Figure 4, issues 3-6). All of these actions need to be implemented while considering time, employee, and other constraints of the managers actually doing the monitoring.

Useful questions. Although, the specific questions asked about the fish communities are dependent on agreed upon bio-social goals and identification of the desired biological reference system, we can start by addressing the following questions about the health, function, and desirability of the fish community (2003 Narrative Figure 5). Relative to the baseline or reference community, how many species are there?; From which families? How are the species distributed by habitat?; By tolerance to abiotic conditions?; By food consumed and trophic role? What is the proportion of native and non-native/introduced species? How long have the non-natives been in the system? Are there threatened or endangered species? Are there species of special concern? Is there a diverse collection of species? Is there a range of sizes within and across species? Are there young-of-year fish indicating natural reproduction? Are there obvious indicators of disease? Which communities should we watch?; Which are treasures? Are there changes through time (2003 Narrative Figure 5)? We try to answer these questions in the narrative that follows although as more precise goals are set for each park, these questions should be modified.

General Approach to Sampling Fish

To identify what is there, managers must sample the fish community representatively, using a standardized, repetitive unit of effort to document the present community and to quantify how things are changing. To do this requires that specific sampling questions and considerations be addressed (2003 Narrative Figure 6). First, the appropriate spatial scale must be determined by deciding which systems should be sampled in what locations (2003 Narrative Figure 6). To sample mobile freshwater fish representatively, we need to use a variety of gear that will catch the entire range of fish species and sizes. For freshwater fish, a relatively large area must be sampled to catch the range of fish present. By definition, this consideration reduces the numbers of replicates of gear that can be set in any system. In addition, if all systems can not be evaluated, a subsample of systems must be chosen. In our expert opinion, representative systems should be sampled with this representative suite of gear. Representative systems can be chosen using a random number table or simply with an eye towards distributing effort across a range of systems. In addition, managers engaged in a monitoring regime should stratify (divide the sampling) by habitat where necessary (2003 Narrative Report Figure 6). For pond and impoundments, we recommend stratifying by inshore and pelagic habitats and focusing on the inshore/littoral habitat in which most of the freshwater fish in these systems reside (2003 Narrative Figure 7). In streams, we recommend stratifying or dividing habitats based on a qualitative assessment of stream size and flow. We discuss the specifics of this approach in the sampling methods that follow. Second, to inventory and monitor effectively, the appropriate temporal scale must be identified (2003 Narrative Figure 6). Specifically, managers need to address when and how often they should sample at what times. In our expert opinion, we should sample to minimize "noise" and maximize meaningful variation that will detect change through time and space (2003 Narrative Figure 8). For monitoring fish, sampling once a year in late summer/fall is the least noisy indicator of yearly trends (2003 Narrative Figure 9). For traps and nets, night is generally thought to be the best time to sample because it covers the crepuscular period when maximum movement occurs. But in making day night net/trap comparisons, we found that ponds can be sampled in the day without significant loss of species diversity if this is logistically more convenient. Third, managers engaged in biological monitoring need to choose the appropriate taxonomic scale (2003 Narrative Figure 6). Determining what is the most useful response (species presence or absence, relative abundance, biomass, guilds, functional groups, food webs) is an important decision. The first three responses, i.e., presence absence, relative abundance, biomass, provide very different information and have different strengths and weaknesses. Presence-absence or what species are there emphasizes all species equally whether rare or common (2003 Narrative Figure 10). Presence-absence provides the least information and is least sensitive response but is also the least variable and requires the least amount of effort (2003 Narrative Figure 11). It is important to note, though, that because a catch of one is weighted the same as a catch of 1000, it is very easy to misinterpret presence-absence data if it is used alone. Relative abundance or numbers of each species caught with a standard unit of gear emphasizes abundant species especially small fish (2003 Narrative Figure 10). This response is intermediate in sensitively, effort, and information (2003 Narrative Figure 11). Biomass or species-specific weights emphasize large fish (2003 Narrative Figure 10). Biomass is probably the most sensitive and informative response but requires the most effort (2003 Narrative Figure 11). Note that none of these responses effectively evaluates the role of larger, less common, but functionally important species such as predators. All of these responses have pros and cons and the choice of response should be based on specific goals and time constraints. In our expert opinion, a future monitoring program should quantify a response that can detect changes by repeating a standardized unit of effort through time. This standardized, representative, repeated effort needs to be intensive enough to detect meaningful variation, realistic enough that the effort can be maintained annually, but not so intensive that confusing "noise" overwhelms meaningful trends. We recommend documenting species-specific relative abundance annually or biennially (every other year). Finally, the optimal sampling regime should use scientific principles (replicates, controls, statistics) where possible, and consider time, personnel, and monetary constraints. Specifics of how these philosophical considerations are implemented for sampling freshwater fish is described in detail in the methods and protocol sections.

Sampling Methods and Recommended Monitoring Protocols

Our team spent considerable time in planning and testing the sampling methods that we used in the fish inventory. As a result, we recommend that the exact methods we used to sample fish be repeated in future monitoring. As a result, the following section, serves two purposes. It reviews sampling methods and it proposes future monitoring protocols. To change this section from sampling methods to monitoring protocols, replace the word " were" with "should be" throughout and change past tense of other verbs to future tense.

Habitat

Habitat Assessment. Because fish sampling gear works differently in different habitats, first, all aquatic resources were visited in the field and identified, qualitatively, by habitat type (Original 2002 Final Report, p. 54). In many cases, difficult access prohibited sampling. Second, representative sampling locations for each habitat type were targeted using a map. To do this, all aquatic habitats were marked on a topographic or GIS map and measured. At this time, access points were identified. For standing water, sampling gear usually can be set throughout the low flow impoundment or pond habitat with the use of a boat. Hence, using a map, we divided the lake or pond into sections and used a random number generator to chose locations for sampling gear. When that was not possible, we identified representative locations throughout the pond to sample. For stream habitat, after identifying the resources by habitat type on a map, we selected 5-10% of each type of stream habitat for sampling. First, we gave each 25 m transect a number, then we selected 10% of each habitat type using a random number generator within the constraints of access points. Often this approach was impractical given logistic constraints. In this case, we selected sites such that all habitats were sampled.

Overall plan for sampling fish in lakes, ponds, impoundments (standing water)

Standing water. Choice of gear was based on habitat. For standing water (lakes, ponds, and impoundments), we used a standardized suite of gear that included some combination of fyke nets, minnow traps, and trammel nets. A typical standardized suite of gear included 1-3 fyke nets, 5-15 minnow traps, and if the resource was large enough 1-3 trammel nets (2003 Narrative Figure 12; Original 2002 Final Report Figure 1). Under optimal conditions, this standardized suite of gear was set across several representative sites within the pond then repeated on several adjacent day/nights. When the habitat was small or presented difficulties with access or other logistics, fewer pieces of gear were included in each standardized suite of gear. For example, sometimes the number of fyke nets was reduced to 1-2 or under special circumstances increased to 5 per set. In many small ponds and impoundments, trammel nets were too large to be set. Beach seines were added to the suite of sampling gear on the rare occasion where the bottom was smooth. The standardized suite of gear (fyke nets, minnow traps, trammel net, seine) was set repeatedly through time and space until no new species were caught. Before sampling, three intensities of sampling with different time commitments were proposed for each gear type in each habitat type (2002 Original Final Report Table 18-Small lake and low flow impoundments; 2002 Original Final Report Table 19-High flow impoundments). Based on our knowledge of the gear, resources, and time constraints, for monitoring, we used a medium intensity and recommend this level of effort for future monitoring. Specific numbers of each gear type varied with the specific aquatic resource. The specific numbers of each gear fished at each park, each resource within a park, each site within a resource, and total pieces of gear fished overall be found in the Original 2002 Final Report Tables 28-35, p. 129-188).

Specific deployment protocols for standing water gear

Fyke nets. The objective of using fyke nets is to sample a range of small-medium sized fish in the littoral zone of most lentic habitats (2003 Narrative Table 1; Original 2002 Final Report Table 21, p. 117). Although this gear catches a range of fish sizes and species, the fish must be actively moving such that they hit the lead and are guided into the hoops. The fyke net is typically set four hours before sunset and allowed to fish for eight hours specifically encompassing the dusk time period. To set the net without a boat, one person is needed. With a boat, two people are needed. Two people are best for pulling the nets. As stated above, the number of nets set are resource specific. To set the nets, move the fyke net and two anchors to the location where the net will be set. Carrying all hoops, place the anchor for the net lead on or close to the shore. Fully extend the lead and net perpendicular to shore by walking or maneuvering the boat in reverse. The front hoop should ideally be set in a meter of water with no more than 1-2 inches above the water surface. Before dropping the anchor, check that the net is tied and the float is in place. After about 8 hours, pull the net. To do this, slowly and carefully approach the front hoop, grab the front anchor, quickly grab either side of the hoop, and quickly scoop the entire hoop out of water. Holding the first hoop, shake fish toward the end compartment. Gather second hoop and shake again. Continue gathering hoops and shaking the net until all fish are in the last compartment. Another person will need to untie the bottom of net, remove the float, and assist the person holding the net by shaking all fish into a live well. Return the float to the net and tie the cod end. Fyke nets can be set in most inshore habitats where the depth increases gradually. Of particular utility for this gear is that the bottom need not be smooth. Fyke nets are low tech and easy to set. Generally, fish and turtles survive long periods (hours) in these nets without mortality especially when a float is placed in the terminal hoop. However, fyke nets don't catch some species, and, for all species, catches can be variable. Hence a number of fyke nets need to be set through time and space (2003 Narrative Table 1; Original 2002 Final Report Table 21, 117).

Minnow Traps. Minnow traps sample small and young-of-year fish in the littoral or inshore habitat of most lakes, ponds, and impoundments (2003 Narrative Table 2; 2002 Original Final Report Table 22, p. 119-120). Minnow traps are usually broken in halves for storage. To set the traps, clip two matching halves together and attach a floated line to the clip. Set the minnow traps on their side in 1 meter of water or a depth equal to the first hoop of the fyke net. After 4-6 h, pull traps in by the float line. Take the trap apart and empty contents into a live well. This gear can be set in most inshore habitats, is low tech, inexpensive, easy to set, and no boat is needed. Generally, fish survive long periods (hours) in the minnow traps without mortality. But this gear doesn't catch some species and only catches very small fish. In addition, catches can be variable. Hence a number of traps need to be set through time and space.

Trammel nets. Trammel nets sample medium to large fish at the littoral/pelagic interface (2003 Narrative Table 3; 2002 Original Final Report Table 23, p. 121). This net will be set for 1.5 hours before sunset and fished for about 4 hours. This time period is selected to increase the efficiency of the net. One to three nets, each having a different mesh size, can be set simultaneously. Two people are necessary in order to complete all aspects of this task. To set these nets, make sure the net is packed/folded so it will deploy without tangles. From a boat, attach an anchor to one end of the lead line and a float to one end of the float line. Place anchor in approximately 1 meter of water. Then throw the float over. In order to keep the net perpendicular to the near shore, one person will need to slowly maneuver the boat in reverse toward a fixed point on the other shore line. This is why a motor is needed. As the boat is reversing, the other person will be evenly guiding the lead and float line out the front of the boat. Upon reaching the other end of the net, the driver should stop the boat. The person with the net should attach the other anchor to the lead line and the other float to the float line. A well-set net should be relatively straight. Drop the anchor and float overboard. After setting the net, drive along the net to check for twists and tangles. If twists and tangles are present, the samplers may need to reset net. To pull the trammel net, slowly approach the shallow float. Pull this float and anchor. Detach float and anchor before placing net into the transport box. One person should man the float line and the other person should man the lead line. Evenly pull in the float and lead lines. Disentangle any fish and place in a live well. Upon reaching the end, pull in and detach the deep float and anchor. On a positive note, the trammel net, along with gill nets, are examples of the only gear that catch this size fish in this habitat. On the negative side, trammel nets don't catch all species, catches can be highly variable, and this gear requires a boat, motor, and two somewhat skilled workers. Furthermore, large numbers of schooling fish can be caught, and if these fish are left too long in the net, they will die.

<u>Beach Seine</u>. The beach seine samples a range of fish, mostly small to medium, in the littoral zone of most standing water habitats (ponds, lakes, and impoundments ; 2003 Narrative Table 4; Original 2002 Final Report Table 24, p. 123). However, large fish, because they have a sensitive lateral line and strong swimming ability, often escape. The beach seine is fished in 33 meter sections. To maximize the effectiveness, seine transects can be done at night although daytime seining can catch fish too. To deploy this gear, at least two people are needed. To prepare the site, measure out a transect, usually 33 m. Avoid disturbing, i.e. walking through, the site. To fish the transect, unwrap the net and extend net perpendicular to shore <u>making sure that bag is open</u> (extended away from the direction you are moving). Pull seine parallel to shore with the

shallow water person maintaining a water depth of a few inches. The deep water person should stay in 1 meter of water. The deep-water person should remain slightly ahead of the shallow water person throughout the transect and maintain a distance of at least 25 ft. between poles. At the end of the transect, the deep-water person should move shallower in order to meet the shallow-water person simultaneously at the 33 m endpoint. If the net gets snagged on rocks or branches, the fish will escape, so the bottom of the pond <u>must</u> be clear. We recommend clearing a seining path ahead of time. After laying poles on ground, each person should grab a lead line and corresponding float line and evenly pull each end of the net until they reach the bag. Each person should grab a corner of the bag and decrease the size of the bag by rolling the sides down. Pull all fish out of bag and place into a live well. Shake netting to remove excess debris and compactly roll seine for storage. This gear is low tech, relatively easy to use, can produce good catches, but requires a smooth bottom and is biased towards small-medium fish.

<u>The standardized suite of gear</u>. Using combinations of different types of gear is important as each gear catches a different size of fish and some gear work best in certain parts of the pond/impoundment. For example, fyke nets can be set in the shallow area of almost any pond, regardless of the substrate, and can catch a range of fish from medium-small to medium-large. However, catch is variable and a number of fyke nets need to be set simultaneously. In addition, fyke nets target active fish and a number of fish species avoid them. Minnow traps can also be set in almost any resource, are easy to deploy, and often catch large numbers of small species and young-of year fish. However, the catch rate of minnow traps is also highly variable and a large number of traps need to be set. Trammel nets are one of the few gears that can catch larger fish at the littoral-pelagic interface. However, trammel nets are somewhat difficult to set, fish can avoid them, catches are variable, and fish can die if left too long. Beach seines can catch a range of

small to medium fish but are completely ineffective if the bottom is not smooth. Unlike other organisms, fish sampling cannot be successfully sampled at a small scale. Hence, using all of these gear together is the only way to be assured that catches are representative. Repeating combinations of gear is the only way to test if the majority of species are being caught. The standardized amount of gear can vary across systems/resources/parks but the same amount of gear should be repeated every time the individual system is monitored (every year or every other year) as that is the only way change through time can be detected. Sampling at dusk or dawn typically gives the best result but gear can also be set in the day if fish are caught. How we set the gear and how we recommend others set the gear is outlined in detail in the gear protocols that follow (2002 Original Final Report Table 21- Fyke Net; Table 22-Minnow Trap; Table 23-Trammel Net; Table 24-Beach Seine).

A typical sampling routine used to sample standing water was as follows. (To change these methods to a protocol change "were" to "should be.") First the pond/impoundment was scouted and suitable and unsuitable sites for all gear identified. Then suitable locations were selected that sampled the entire resource. While light, all nets and traps were cleaned, dried, and packed for optimal deployment. Fyke nets were stacked with anchors and leads carefully organized. Minnow traps were put together and floats attached. Trammel nets were folded into a carrying tote so that they would go into the water without tangles. About an hour or two before dusk, the fyke and minnow traps were set. To do this, we dropped two people at different sides of the pond where they deployed the fyke and minnow nets on foot. Then, the trammel net was deployed from the boat using at least two samplers. While the nets and traps fish, a beach seine was pulled and fish worked up. After 4-6 h, the trammel net was pulled, fish were processed. Finally, the fyke nets and minnow traps were retrieved and fish worked up. Specific details of deployment are in the protocols tables cited above.

Flowing water general sampling plan

Flowing water. For flowing water (streams and rivers), backpack electrofishing was consistently used. We sampled a 25-m transect in an upstream zigzag pattern (2003 Narrative Figure 13; 2002 Original Final Report Figure 2). These 25-m transects were repeatedly sampled, during daylight, until no new species were caught. Before sampling three intensities of sampling with different time and effort commitments were identified (2002 Original Final Report Table 20 a-c, Lower, Moderate, and Gradient Streams). We used and recommend option 1 (25 m transect/habitat unit) coupled with a medium to high intensity (2-5 transects) based on our knowledge of the gear, the habitat, and time constraints. How we set the gear and how we recommend others set the gear is outlined in the gear protocols (2003 Narrative Table 5; 2002 Original Final Report Table 25, Backpack Electrofisher).

Protocols for deployment of specific flowing water gear

Backpack electrofishing samples a range of the fish species and sizes that inhabit riffles and shallow pools. At least 2 people are needed. Electroshocking should never be done alone for safety reasons. Electrical current is used to stun fish. Their muscles are involuntarily attracted to the positive current then they are stunned when they enter the field. A 25 meter reach of stream is sampled with one upstream serpentine pass of the electrical field. Once the representative habitats at a given park have been determined, transects were randomly chosen from within a habitat type. To prepare a transect, we measured 25 meters along the shore. All participants in electrofishing should be wearing appropriate gear (shock proof chest waders and rubber gloves). To deploy the shocker, attach the cathode and anode to proper locations and check for the correct settings. The shocker should be put into the backpack and one of the assistants who is not wearing the backpack should connect the battery to the unit. Prior to beginning the transect, test the unit out on a small section of stream. To fish the transect, with 1-2 assistants each carrying a net and live well (shocker can also carry net), walk upstream diagonally from one side of stream to other side of stream while holding switch in ON position. As fish surface, release button temporarily to net fish and place in live well. Proceed in this manner through the remainder of transect. Some fish float when stunned, others sink to the bottom, so watch carefully. At the end of the transect, if not proceeding directly to next transect, an assistant should disconnect the battery prior to transporting the unit any distance. The next transect must begin at least 10 meters past the endpoint of the previous transect. Process fish after each transect. Backpack electrofishing is the only consistent gear for stream sampling and can produce good catches. But electrofishing can also be dangerous to fish and humans and it only works in relatively shallow water. In addition, the samplers need to be able to walk safely so the bottom needs to be somewhat smooth. Because this method can be dangerous, great care should be exercised. Keep all non-rubberized body parts out of the water. Watch for dogs and children on the bank. Also, the person running the shocker should watch others so they can stop the electricity if someone slips.

General Sampling

Sampling Season. Aquatic resources for all parks were sampled from August to November, 2000 with additional sampling done at Cape Cod National Seashore in 2001. Catches will be less variable in the fall and we recommend this for monitoring. Pond sampling can be done day or night.

Night time sampling often gives better catches but sometimes this is impractical. If the nets/traps can be set over a dawn or dusk period, catches may be enhanced. If the nets and traps are left in too long, fish mortality may occur so fishing time needs to be monitored. Electrofishing needs to be done in the daytime.

Fish Processing. In the field, field identifications were made. Some representatives of each species were placed in ethanol for our own use in checking field identifications. A complete set of voucher specimens was not part of this project and that is not how these samples were intended to be used. All fish were counted and identified (2003 Narrative Table 6; 2002 Original Final Report Table 26- fish processing protocol). Then fish were returned to the wild after sampling. After field sampling, representative samples of each species were taken to the University of Massachusetts Museum and keyed out using critical characters (2002 Appendix) suggested in the relevant key (see references in the 2002 Fish Key). A field guide of these characters was composed (2002 Fish Key). Some species (like minnows) should routinely be taken to the lab for identification. Reference specimens were stored in labeled jars with an ethanol-water mixture for frozen in labeled bags. Equipment needed for monitoring is suggested (2002 Original Final Report 27, p. 128).

Effectiveness of sampling and sampling units. How we evaluated if our sampling caught 90% of the species is specified in detail in the 2002 Original Final Report (Approach and methods: p. 52; Amount of available habitat we sampled: Table 16, p. 101; Results of our effectiveness: Table 128, p. 322). Briefly, we tried to repeatedly sample standardized units so we could document the number of new species that were caught each time we repeated this standardized effort. However, this repetitive standardized sampling is not a useful tool if the standardized unit is not intensive enough to catch a representative sample of fish. Because systems vary in size and difficulty in sampling, the amount of standardized effort that can be meaningfully varies. This standardized sampling unit upon which any estimate of variation is based, i.e., N, varies with the sampling goal (monitoring vs research) and with the system but in all sampling the philosophical constructs are the same. For stream sampling, the standardized unit that was repeated was always a 25 m electrofishing transect. By comparing catch in subsequent transects, we could evaluate if new species were being collected and infer when we caught about 90% of existing species (2002 Original Final Report 2002 p. 52; Table 128, p. 322). In standing water, for inventory and monitoring, we tried to use a cluster of fyke nets, minnow traps, trammel nets, and seines as an sampling unit that could be repeated elsewhere in the pond. But, because of variability in catch, sometimes we needed to group all gear sampled within a sampling day/night together to get a representative estimate of catch. In this case, the replicate or repeated effort occurred across time, i.e., on several days/nights. For much of the pond inventory and monitoring, we subjectively evaluated if new species were added. For research, fish caught in all gear set in a kettle pond comprised a unit of effort and all fish caught in all gear were analyzed together. For detecting changes through time, it is not necessary that the same, standardized effort or combination of gear be used in all resources at all parks (although initially we tried to establish this). What is important is that a representative effort be repeated with the same effort through time <u>at each specific resource</u>. In general, we feel this was an effective approach to sampling.

Results

<u>What habitats are there?</u> St. Gaudens National Historic Site contains four aquatic resources with freshwater fish: Blow-Me-Down Pond, Blow-Me-Down Brook, Blow-Me-Up Brook, Farm Pond (2003 Narrative Table 7; 2002 Original Final Report Table 13, p. 80) These resources

include low flow impoundments/small ponds (Farm Pond), high flow impoundments (Blow-Me-Down Pond), lower gradient streams (Blow-Me-Down Brook), moderate gradient stream habitat (Blow-Me-Up Brook) and higher gradient streams (Blow-Me-Down Brook, Blow-Me-Up Brook; 2003 Narrative Table 7; Map 8B; 2002 Original Final Report Table 13, p. 80; 2002 Original Final Report Map 8B). Low flow impoundments are bodies of water with a man-made dam that form a small pond or lake with minimal inflow and outflow. Ponds are similar small standing water systems that have no dam. Lower gradient streams are slower moving, soft-bottomed systems with many large pools. Moderate gradient streams are defined as faster moving, gravel/cobble bottomed systems, with riffles and runs. Higher gradient streams are extremely fast moving, rock to boulder bottomed systems, with runs, falls, and plunge pools (2002 Original Final Report, p. 54). Defining habitat type is important for both the selection of effective sampling gear and to identify potential fish communities.

Habitats at St Gaudens were surveyed in October, 1999 (2002 Original Report Executive Summary, p. 39). This system was sampled for fish in October, 2000 (2003 Narrative Table 8; 2002 Original Final Report Executive Summary, p. 39; 2002 Original Final Report Table 33, p 151). We tried to sample habitat types with a standard, repetitive effort. However, sometimes the standard effort had to be modified because of system size, bottom type, or other constraints. In general, we sampled low, medium, and high gradient streams in 25 m transects repeated until our catch curve flattened out, i.e., no or few new species caught or 10% of the habitat was sampled. In general, ponds and low flow impoundments were sampled with repetitions of 15 minnow traps and three fyke nets. When the system was large enough, a trammel net was used. In the atypical circumstances in which bottoms were hard and smooth, a beach seine was also included. In smaller systems, this standardized suite of gear was reduced to 1 fyke net and 15 minnow traps.

During the three days of sampling, 15 sites within four resources representing four habitat types were sampled with a total of 91 units of effort/gear (2003 Narrative Table 8, Map 8C/D; 2002 Original Final Report Executive Summary, p. 39; 2002 Original Final Report Table 33, p. 151, Map 8C/D). Of these, 18 units of stream habitat (Blow-Me-Up and Blow-Me-Down Brooks) were sampled using a backpack electrofisher in replicates of 25 m. This effort surveyed 17-21% of the total flowing water habitat (2003 Narrative Table 8; 2002 Original Final Report Table 33, p.151, 2002 Original Final Report Table 16, p. 101-102). During this same sampling period, the two impoundment/small pond resources were sampled at 11 sites representing 73 units of effort (2003 Narrative Table 8; 2002 Original Final Report Table 33, p. 151; 2002 Original Final Report Table 16, p. 101). Blow-Me-Down Pond was sampled three times with the traditional standing water gear (3 fyke nets, 15 minnow traps, 1 trammel net). A more limited suite of gear, i.e., 1 fyke net and 15 minnow traps, was used once to sample the smaller farm pond (2003 Narrative Table 8; 2002 Original Final Report Table 16, p. 101; 2002 Original Final Report Table 33, p. 151.)

Fish Community. Overall, St. Gaudens contained 12 freshwater fish species: blacknose dace, brook trout, brown bullhead , common shiner, creek chub, fallfish, golden shiner, longnose dace, pumpkinseed sunfish, slimy sculpin, spottail shiner, and white sucker (2003 Narrative Table 9; 2002 Original Final Report Table 84 p. 253). These species represented six families: Cyprinidae (common shiner, blacknose dace, creek chub, fallfish, golden shiner, longnose dace, spottail shiner); Salmonidae (brook trout); Ictaluridae (brown bullhead), Centrarchidae (pumpkinseed sunfish), Cottidae (slimy sculpin), and Catastomidae (white sucker). All of these are natives (2003 Narrative Table 9; 2002 Original Final Report Executive Summary, p. 39; 2002 Original Final Report Table 63, p. 222).

No fish were caught in the small farm pond (2003 Narrative Table 19-11; 2002 Original Final Report Table 73, p. 238; 2002 Original Final Report Table 84, p. 253). Brook trout and slimy sculpin were found in the medium gradient stream habitat. Longnose dace and spottail shiner were found in both moderate and high gradient stream habitats. Brown bullhead, golden shiner, and creek chub were found in the high flow impoundment. Blacknose dace and white sucker were found in the high flow impoundment, moderate gradient and high gradient stream whereas fallfish were found in the high flow impoundment and moderate gradient stream habitat. Common shiners and pumpkinseed were found in the high flow impoundment and high gradient stream habitats (2003 Narrative Table 10-11; 2002 Original Final Report Table 73, p. 238; 2002 Original Final Report Table 84, p. 253).

Common shiner, blacknose dace, creek chub, fallfish, longnose dace, spottail shiner, and white sucker are typical stream fish. Their adaptations to living in flowing water include either a flattered body, large fins, or an ecological affinity to shelter in the stream bottom or edges. All but the white sucker feed on invertebrates either on the bottom or in the drift. White suckers are omnivores consuming a wide variety of bottom materials. Blacknose dace are an extremely common stream fish and are considered tolerant of a wide variety of water conditions. Suckers, on the other hand, are often considered to be characteristic of higher quality habitat conditions. The habitat requirements of cyprinids or minnow differ with the species. Golden shiners are planktivores found in both lakes and streams although most often lakes. The omnivorous brown bullhead are also typically found in slower, mostly standing water, systems. Pumpkinseed sunfish occupy both standing and flowing water systems often seeking out vegetation. Brook trout occupy pools of clean, relatively fast flowing water in hard-bottomed streams. None of these species are threatened, endangered, or of special concern. Across all habitats, blacknose dace, common shiner and golden shiner were very abundant (2003 Narrative Table 12; 2002 Original Final Report Table 94, p. 263). Most species occurred in moderate abundance except the fallfish, of which only two were caught (2003 Narrative Table 12; 2002 Original Final Report Table 94, p. 263).

These species cover a range of ecological roles. Golden shiners are obligate planktivores. A number of species including blacknose dace, common shiner, creek chub, fallfish, longnose dace, pumpkinseed, slimy sculpin, and spottail shiners feed on invertebrates. Although these invertivores are all diet generalists, some species like pumpkinseed have morphological adaptations that allow them to thrive on benthos. Small brook trout can feed on invertebrate drift whereas large trout may consume small fish as well. Brown bullhead and white sucker have omnivorous eating habits.

Previous records. Previous sampling records are useful to determine the potential species pool. However, less common and highly variable (but not necessarily rare/threatened/endangered) species may not be caught in every inventory effort because of variability and chance not because these species are decreasing in abundance. These less common and highly variable species often comprise a substantial portion of any animal community (i.e., this is the basis for the lognormal distribution of species often used in theoretical models). The catch of these less common and highly variable species is exacerbated by different sampling methodologies and levels of effort. Hence, it is difficult to draw conclusions about changes in freshwater fish communities from occasional surveys. This is why we recommend repeating the same type of sampling at the same sites at the same effort levels for several years to get a baseline species list. Once this is established, changes through time can be interpreted with increased confidence.

We compiled previous information on fish sampling (2002 Original Final Report Table 36, p. 189; 2002 Original Final Report Table, p. 332-334). The most recent survey by Cook (1986;2002 Original Final Report Table 36, p. 189; 2002 Original Final Report, p. 333) found many of the same species we did (common shiner, blacknose dace, brook trout, brown bullhead, creek chub, fallfish, golden shiner, longnose dace, and common or white sucker). He also caught ten species we did not (chain pickerel, red belly dace, bluntnose minnow, rock bass, redbreasted sunfish, bluegill, yellow perch, and tessellated darter). Of these, bluntnose minnow, rock bass, redbreast sunfish, bluegill, yellow perch, and tesselated darter were relatively uncommon (1-8 individuals). We caught two new species, i.e, slimy sculpin and spottail shiner. Likely, with the proximity of the diverse Connecticut River, the SAGA systems may have constant additions and deletions to and from the local species pool. In our opinion, we should be careful about making too much of these comparisons until we have a baseline pool from a standardized, repetitive sampling. How native or non-native/introduced status was determined is outlined in the 2002 Original Final Report Table 57, p. 216. Further details of fish ecology can be found in the 2002 Fish Key.

Anthropogenic Effects

Land Use. A major source of anthropogenic effects are those associated with changing land use. As the amount of forest is decreased and as development and/or agriculture increase, a number of effects can occur that can have adverse effects on freshwater fish. First, as the amount of vegetation decreases, the hydrograph changes. Often more water flows over land and less percolates into the ground water. As a result, extreme flow conditions increase and both floods and droughts are exacerbated. This change in water quantity and especially the variation in water quality can have adverse effects on many fish. Second, roads and other paved areas will increase runoff. Third, a change in riparian corridor can have adverse effects on stream water quality. The resulting increased runoff from development, roads, and an altered riparian area can increase the amount of sediment, nutrients, salt, and car oil in the lakes and streams. A decrease in water quality can, of course, have an adverse effect on freshwater fish by affecting basic physiology/metabolism, increasing disease, and affecting spawning and egg development. Changes in land use should be monitored for the watershed in which the park resides. If land use changes, water quality, sediment, and incidence of disease should be monitored. Seasonal flow regimes should also be documented.

Contaminants. Contaminants from industry can have an adverse effect on fish physiology. In areas where contaminants are know to exist, water quality, contaminant loads, and fish communities should be carefully watched.

Animals that affect vegetation and water flow. Beaver and deer are increasing in many suburban/urban areas. Beaver, by damming streams, can slow/stop flow and change the community from a flowing system to a standing water one. Deer can overgraze riparian areas and cause increased sedimentation and runoff. If either of these animals is common in the area of the park, water quality, flow regime, and fish communities should be carefully monitored.

Dams. Dams are an integral park of many northeastern systems. If drawdown is planned to repair dams, care should be taken not to adversely affect those fish that live in the impoundment margin. This can be done by simply watching how much inshore substrate is dewatered by the drawdown. If possible, avoid drawdown in spring when sunfish are building nests in the shallows.

Stocking, Visitation, and Invading Species. Adding new species to any system can affect existing species. Often with increased human activity, species are transplanted between water bodies. Visitors should be warned about the dangers of this. Stocking should be relegated to tested programs. Monitoring fish species composition should alert the park to new species.

Vegetation: In many systems, aquatic vegetation is critical to fish community structure. Changes in vegetation could change the fish communities drastically. Changes in water quality, nutrients, and other factors that affect aquatic vegetation should be monitored as should the vegetation itself and the fish communities that use it.

All of these effects could be important in any of the NPS sites in the northeast (2002 Original Final Report Table 129, p. 15). All parks are potentially affected by changing land use, changes in water quantity/quality, nutrient enrichment from urbanization and farming, and runoff from roads. At SAGA, special concerns are water quality, land use changes, and dam. A more detailed list of concerns of individual parks can be found in the 2002 Appendix, p 48-51.

Future Work

A good effort was expended in sampling St. Gaudens. Although, it is unlikely that any limited sampling will capture all species, especially, rare species, we think that we sampled a representative portion of the species (Original Final Report Table 128, p. 322). Electrofishing at flowing water index sites and a regular effort of nets and traps at ponds in Blow-Me-Down Pond should provide a good index of changes in species in these systems. Our recommendation is that the northeast parks band together and institute a sampling plan where they work together as a team to sample each park for fish every other year. Future efforts should be expended fine tuning the standardized effort of gear used and the target reference system for the park.

What is our goal in inventory and monitoring?

Maintain present conditions

(a) Establish present conditions
(b) Act to maintain

Restore past conditions

(a) Known previous condition
(b) Historical reference
(c) Better conditions
(d) Eliminate specific problems, e.g.,
  - non-point pollution from a road
  - invading species
(e) Fish restoration, e.g.,
  - River herring
  - Atlantic salmon

Anticipate human impacts

(a) If we know that land use, stream channel, or other adverse human impacts will occur, we can watch for specific effects
(b) But we need to know pre-impact conditions

Optimal biological

(a) Be a good steward
(b) Promote optimal ecosystem health and/or function
(c) Understand how the biological system works
(d) Traditional biological criteria

Optimal social

a) Please residents, the public, or some other human group
b) No law suits, bad press, etc.
c) Positive public interaction/meetings
d) Traditional Social
  "Greatest good for the greatest number" (Pinchot)
  "God and the rock, in the place where god put it" (Muir)
e) Understand how social realm works

Figure 1. Possible goals for inventory and monitoring. Each is discussed further in the text.

Traditional Biological Criteria

Criteria 1:

Native Species
- Historic community
- No invasive species

Criteria 2:

Diverse

Complex

Stable

Resilient

Healthy
- Functioning
- Restored
- Biological Integrity

Natural Reproduction

Figure 2. Possible biological criteria for inventory and monitoring.

Massachusetts Freshwater Fish Species

	Total	Native	Introduced/ Non-Native
Centrarchidae	10	3	7
Percidae	4	3	1
Anguillidae	1	1	0
Clupeidae	4	4	0
Cyprinidae	20	11	9
Catastomidae	4	3	1
Ictaluridae	6	5	1
Esocidae	4	3	1
Umbridae	1	0	1
Salmonidae	7	2	5
Fundulidae	4	4	0
Gasterosteidae	4	4	0
Cottidae	1	1	0
Moronidae	2	2	0
Hartel and Hallowell	71	46=65%	25=35%

Figure 3. Of the freshwater fish species found in Massachusetts given are the number and percent of fish that are native and non-native/introduced. This list is taken from Hartel and Halliwell's web based "Fishes of Massachusetts" key.

<u>WORKING</u> <u>PLAN</u>

(1) Determine what we have

(a) Use <u>representative</u>, <u>standardized</u>, <u>repetitive unit of effort</u> to document the present community

(2) Set bio-social <u>goals</u>

(3) Assess how things are <u>changing</u> (continue 1a above through time)

(4) Institute a continuing program to <u>understand how things work</u> so we can modify the plan

(5) Study "<u>representative systems</u>" in depth relative to #4, then generalize insights to other systems

(6) <u>Anticipate changes</u> with *a priori* hypotheses

Figure 4. Possible working plan for inventory and monitoring.

Questions that describe the fish community

Baseline or reference community

Species

How many species are there?
From which families?
How are the species distributed?
By habitat
By tolerance to abiotic conditions
By food consumed and trophic role
What is the proportion of native and non-native species?
How long have the non-natives been in the system?
Are there threatened or endangered species?
Are there species of special concern?

Diversity and complexity

Is there a diversity of species?

Sizes

Is there a range of sizes within and across species?
Are there young-of-year fish indicating natural reproduction?

Other

Are there obvious indicators of disease?
Which communities should we watch, which are treasures?

Through time

Change

Are there changes through time?

Figure 5. Potential questions to use to evaluate fish communities.

Inventory and Monitoring: Questions and considerations

#1	#2	#3	#4	#5
What do we want?	What is there?	Is it changing?	Why?	What next?

I. Choose appropriate spatial scale,

Question: Which systems should be sampled? Where?

Answer: Sample representative systems.
Stratify by habitat where necessary.
Randomize sampling where possible.

II. Choose appropriate temporal scale,

Question: When and how often sample should sampling occur?

Answer: Sample to minimize "noise" and maximize meaningful variation that will detect change through time and space.

III. Choose appropriate taxonomic scale,

Question: What is the most useful response to quantify?

Answer: Of the options (species, abundance, size, biomass, guilds, functional groups,food webs), sample the response which provides the most useful information to detect changes through time

IV. Repeat standardized sampling through time to detect change

V. Anticipate change by identifying potential impacts and their consequences

VI. Other considerations

(1) Use scientific principles (replicates, controls, statistics) where possible.
(2) Consider time, personnel, and monetary constraints.

Figure 6. Questions and considerations for an effective inventory and monitoring program.

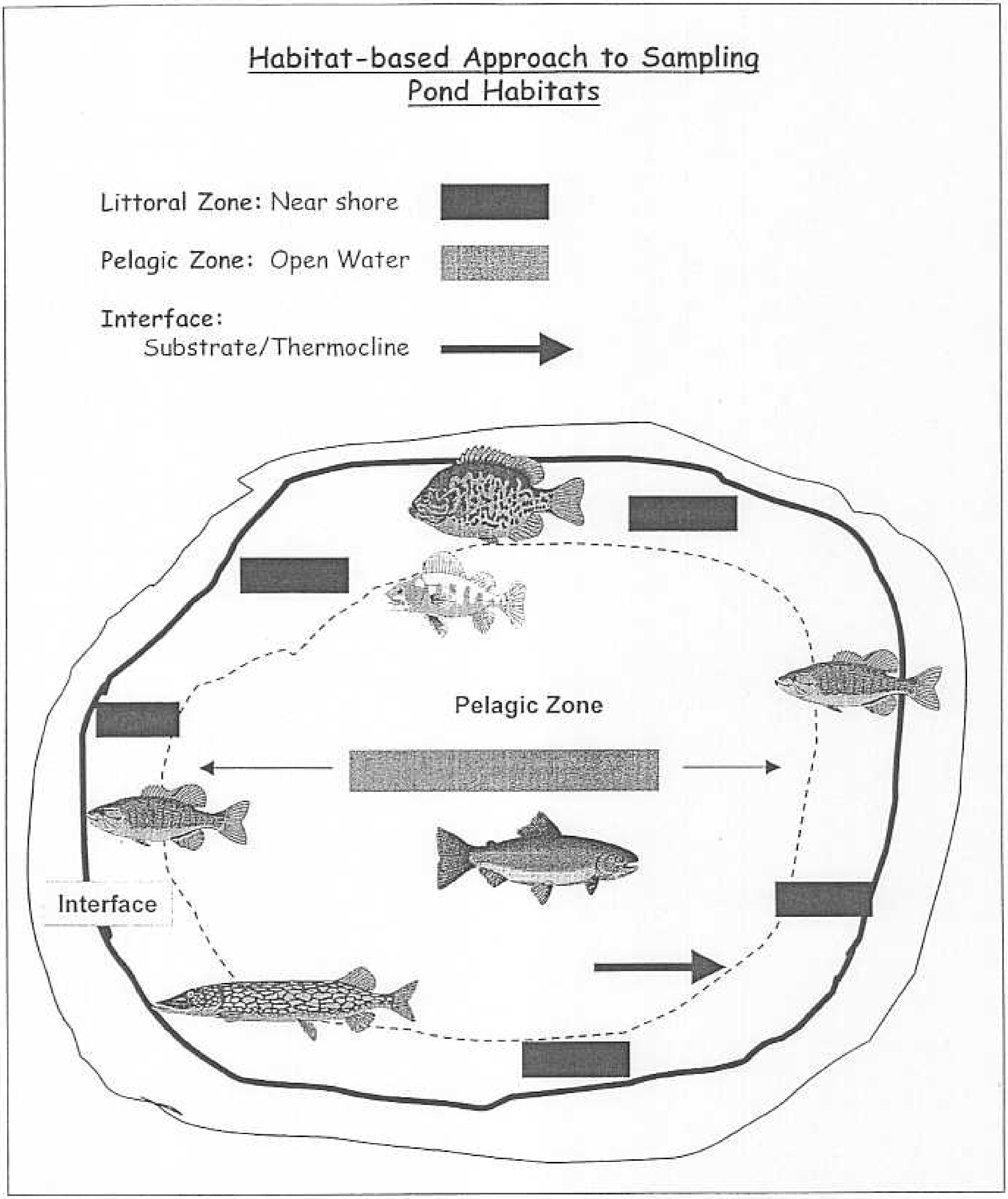


Figure 7. Example of a habitat based sampling program for standing water habitats.

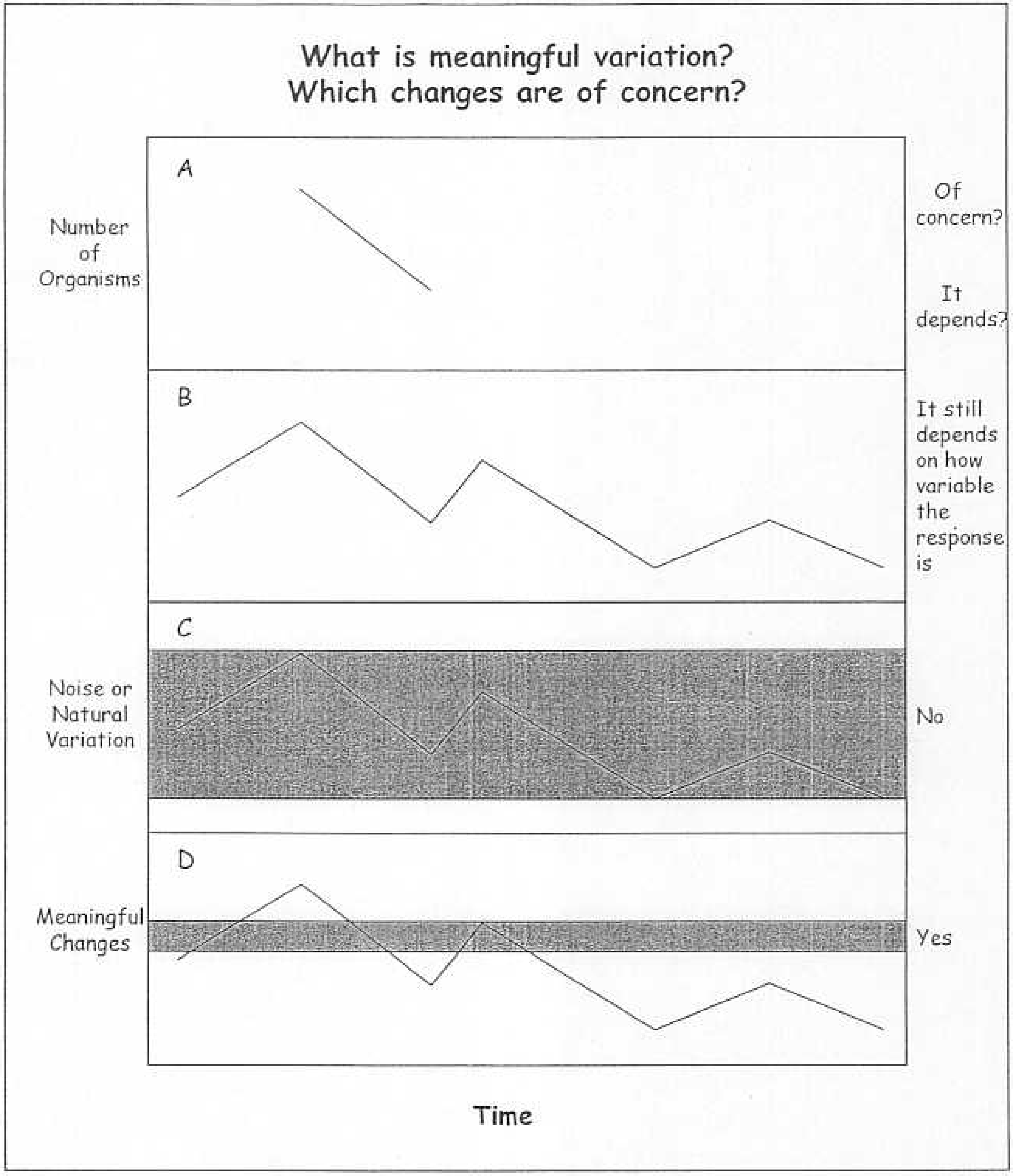
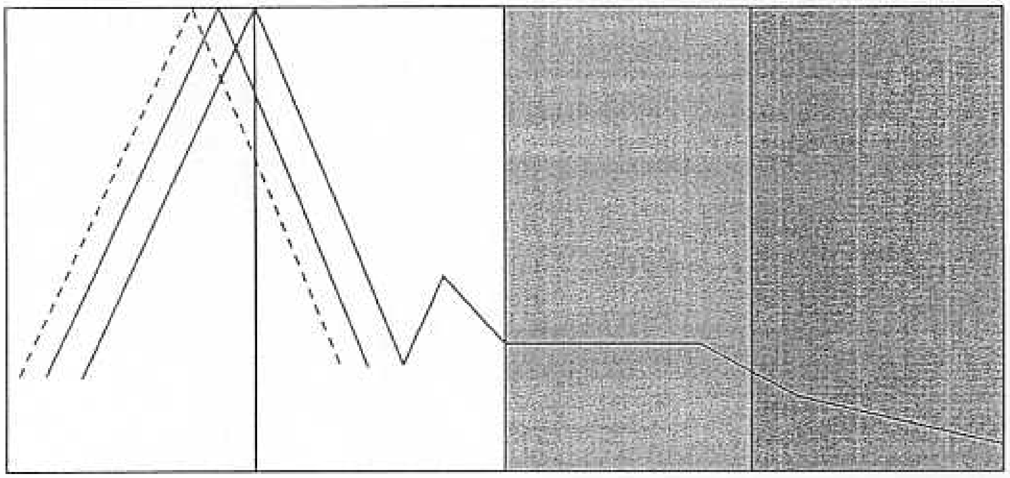


Figure 8. Examples of meaningful temporal changes (D) and those resulting from noise or natural variation (C).

Patterns Through Time
Causes



	Spring	Summer	Fall	Winter
Reproduction:	Yes			
Habitat shift:	Yes			
Mortality:	High	Variable	Low	Medium
Variable:	Very	Very	No	Some
Informative:		Yes		
Sample 1X:			Yes	

Figure 9. Because of high variability in spring and summer, annual monitoring for fish populations is recommended in the fall.

Many responses are possible
Each has pros and cons

Data set	Emphasizes
Presence Absence	All species[1]
Relative abundance	Numbers of fish[2] (esp. small)
Biomass	Larger fish

[1] But rare species are a problem for all responses

[2] For relative abundance to be useful, the effort has to be standard through space and time

Figure 10. Pros and cons for three taxonomic responses for evaluating fish communities 1.

Bottom Line on Response

Least sensitive
Least variable
Least informative
Least work

Response	Emphasizes
Presence Absence	All species
Relative abundance	Numbers of fish (esp. small)
Biomass	Larger fish

None of these pick up the not very abundance but functionally important species like predators

Most sensitive
Most variable
Most informative
Most work

Figure 11. Pros and cons for three taxonomic responses for evaluating fish communities 2.

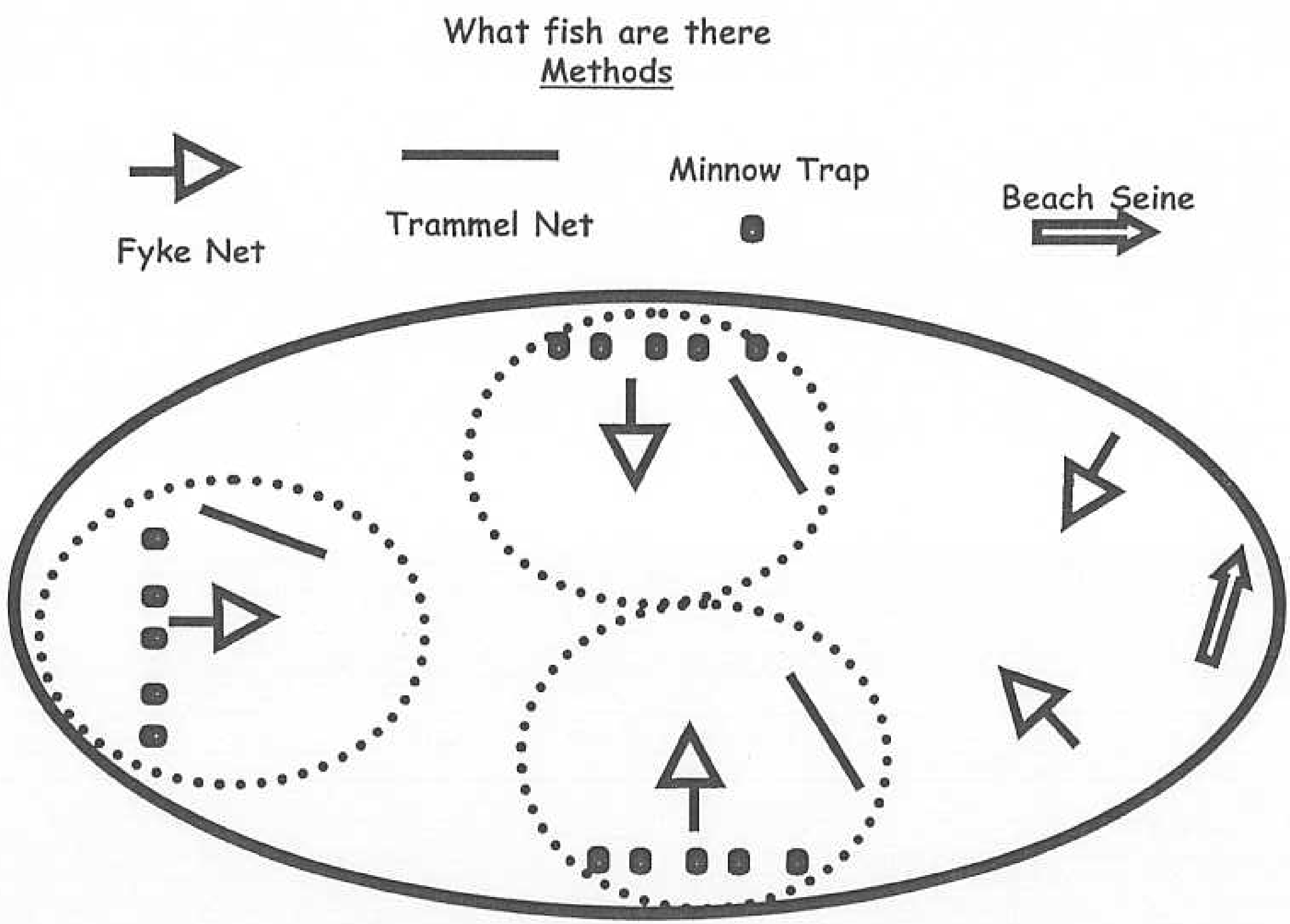


Figure 12. How a standardized suite of gear was set in a pond/impoundment.

Figure 13. Sampling Layout for Lentic Systems

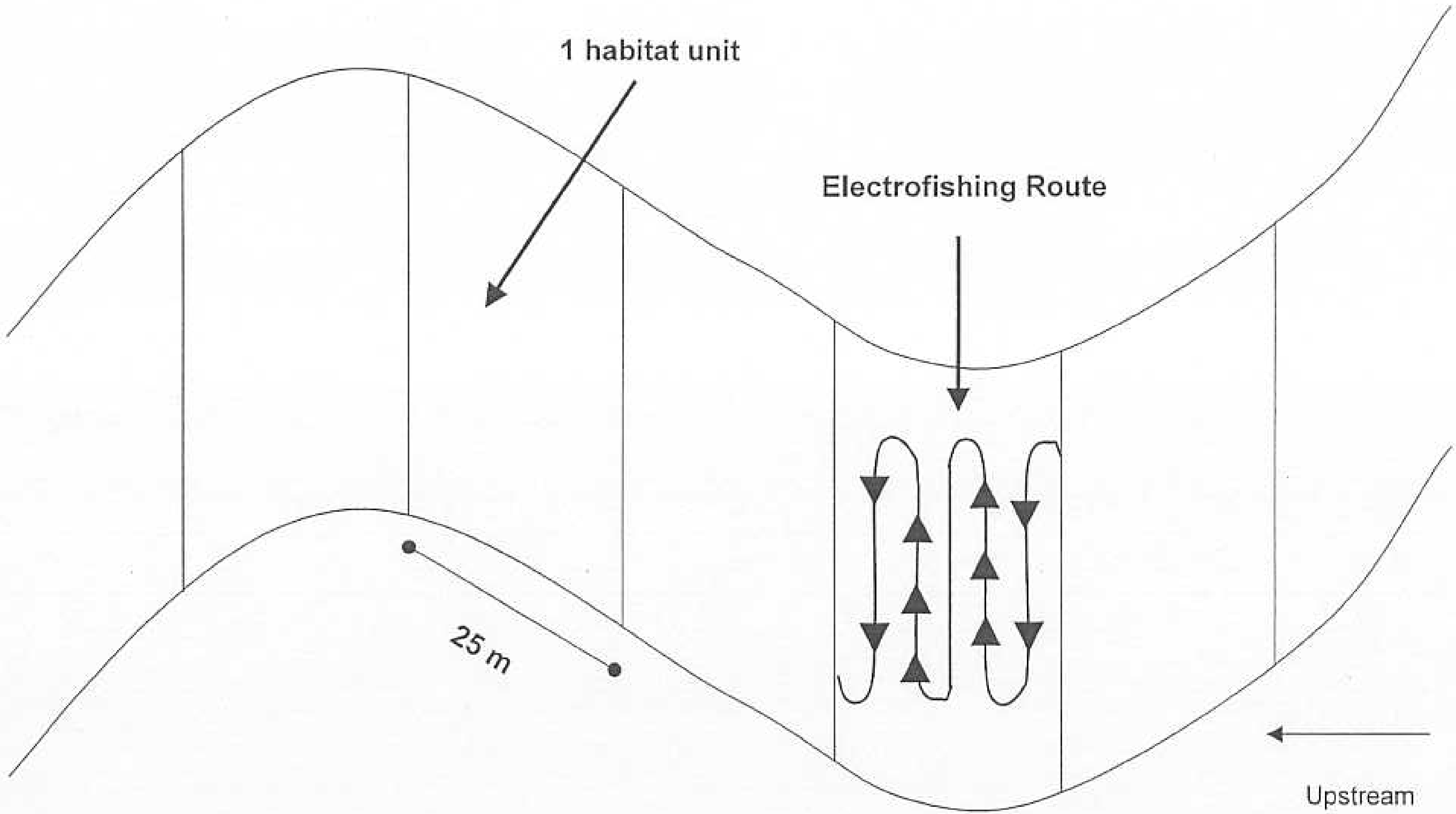
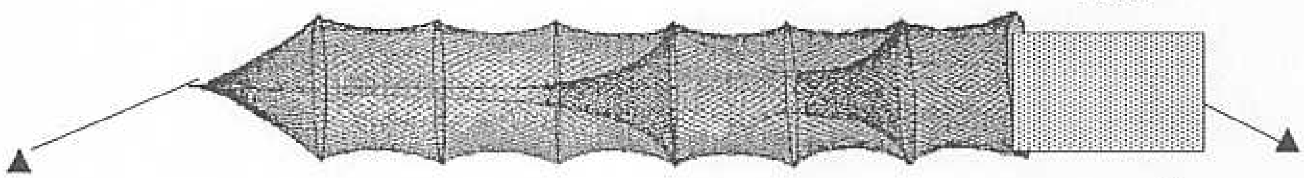


Table 1. Gear Protocols for fyke net. Included are an objective data gained, sampling design, recommended number of people, deploying and retrieving gear, and other considerations.

Gear Protocol: Fyke Net



Objective: Sample a range of small-medium sized fish in the littoral zone of most lentic habitats.

Targets/Data Gained: Littoral zone is sampled for a wide variety of species and sizes. Although this catches a range of fish sizes and species, the fish must be actively moving such that they hit the lead and are guided into the hoops. This will not be true for all species

Description: The net is 12 feet long with 3 hoops each having a 3-foot diameter. A 3 foot deep by 20 foot long lead extends from the front of the net. Both the lead and trap are made of 3/8 inch mesh.

Sampling Design: The net is set 4 hours before sunset and allowed to fish for 8 hours, specifically encompassing the dusk time period.

Recommended Number of People: To set the net without a boat, you will need 1 person. With a boat, you will need 2 people. 2 people are best for pulling the nets.

Amount of Gear Set: Number of nets set were resource specific.

Pros:

- This gear can be set in most inshore habitats where the depth increases gradually. Of particular importance is that the bottom need not be smooth.
- The gear is pretty low tech and easy to set.
- Generally, fish survive long periods in the net especially when a float is placed in the terminal hoop

Cons:

-This gear doesn't catch some species, and catches can be variable. Hence a number of nets need to be set through time and space

-A stable boat is needed to retrieve the nets.

Setting Net:

1. Move nets and two anchors to location where the net will be set.
2. Carrying all hoops, place anchor for lead on or close to the shore.
3. Fully extend lead and net perpendicular to shore by walking or maneuvering boat in reverse.
4. Front hoop should ideally be set in a meter of water with no more than 1-2 inches above the water surface.
5. Before dropping the anchor, check that net is tied and float is in place.

Pulling Net:

1. Slowly and carefully approach front hoop.
2. Grab front anchor
3. Quickly, place hands on either side of hoop and quickly scoop entire hoop out of water.
4. Holding first hoop, shake fish toward end compartment.
5. Gather second hoop and shake again.
6. Continue gathering hoops and shaking net until all fish are in the last compartment.
7. Another person will need to untie bottom of net, remove the float, and assist the person holding net by shaking all fish into a live well.
8. Return float to net and tie.

Comments

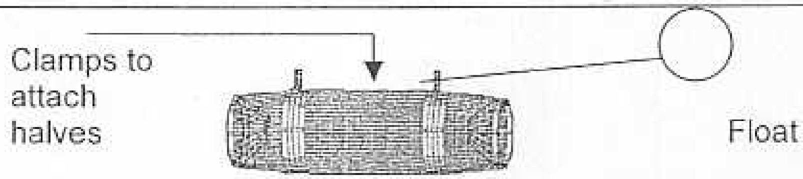
-Although these can be set without a boat, a boat is nice to carry the gear around the pond as you don't want to walk through the sample areas

-A stable boat is essential to retrieve the nets.

-Both deploying and retrieving, a motor is nice but not necessary.

Table 2. Gear Protocols for minnow trap. Included are an objective data gained, sampling design, recommended number of people, deploying and retrieving gear, and other considerations.

Gear Protocol: Minnow Traps



Objective: Sample small and young-of-year fish in littoral zone of most lentic habitats.

Targets/Data gained: The littoral zone is sampled with a focus on smaller fish.

Description: When clipped together in the center, each cylindrical trap measures 9 inches x 17.5 inches with a 1 inch opening at either end. They are made of ¼ inch galvanized wire mesh.

Sampling Design: Five traps complement each fyke net at the depth of the first hoop and are set at the same time as the fyke net (4 hours before sunset).

Recommended Number of People: One person can easily complete this task.

Amount of Gear Set: 15 available traps. Number set was resource s specific.

Pros:

-This gear can be set in most inshore habitats.
-The gear is low tech, inexpensive, and easy to set.
-No boat is needed
-Generally, fish survive long periods (hours) in the traps.

Cons:

-This gear doesn't catch some species,
-Minnow traps only catch very small fish
-Catches can be variable. Hence a number of traps need to be set through time and space

Setting Traps:

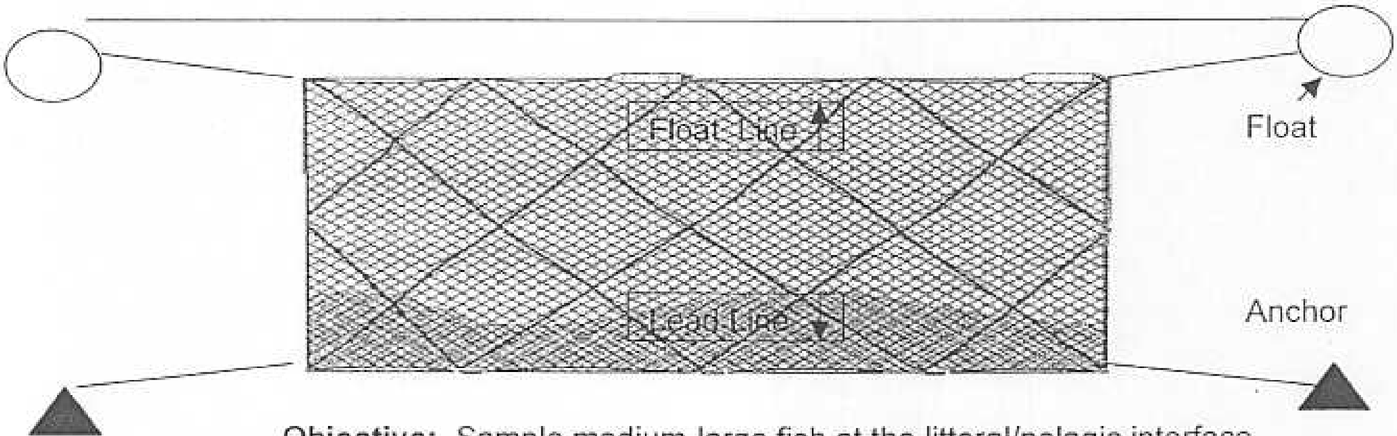
1. Clip two matching ends together.
2. Attach a floated line to the clip.
3. Set on side in 1 meter of water or a depth equal to the first hoop of the fyke net.

Pulling Traps:

1. Pull traps in by float line.
2. Take trap apart.
3. Empty contents into live well.

Table 3. Gear Protocols for trammel net. Included are an objective data gained, sampling design, recommended number of people, deploying and retrieving gear, and other considerations.

Gear Protocol: Trammel net



Objective: Sample medium-large fish at the littoral/pelagic interface.

Targets/Data Gained: The littoral/pelagic interface is surveyed for a variety of fish species and sizes with an emphasis on larger fish.

Description: Each trammel net is 99 feet long with a wall depth of 4 feet, an outer netting of 12 square inch mesh, and an inner mesh of either1 square inch, 1.5 square inch or 2.0 square inch mesh.

Sampling Design: The net will be set for 1.5 hours before sunset and fished for 4 hours. This time period is selected to increase efficiency of net. Three nets, each having a different mesh size, were/can be set simultaneously.

Recommended Number of People: Two people are necessary in order to complete all aspects of this task.

Pros:

- This (along with gill nets) is the one of the few gear to catch this size fish in this habitat.

Cons:

- This gear doesn't catch some species,
- Catches can be variable.
- This gear requires a boat and motor and two somewhat skilled workers.
- Fish cannot be left in this for too long or they will die.

Setting Net:

1. Make sure the net is packed/folded so it will deploy without tangles. Attach an anchor to one end of the lead line and a float to one end of the float line.
2. Place anchor in approximately 1 meter of water. Then throw float over
3. In order to keep the net perpendicular to the near shore, one person will need to slowly maneuver the boat in reverse toward a fixed point on the other shore line. (This is why a motor is needed.)
4. As the boat is reversing, the other person will be evenly guiding the lead and float line out the front of the boat.
5. Upon reaching the other end of the net, the driver should stop the boat. The person with the net should attach the other anchor to the lead line and the other float to the float line.
6. Drop the anchor and float overboard

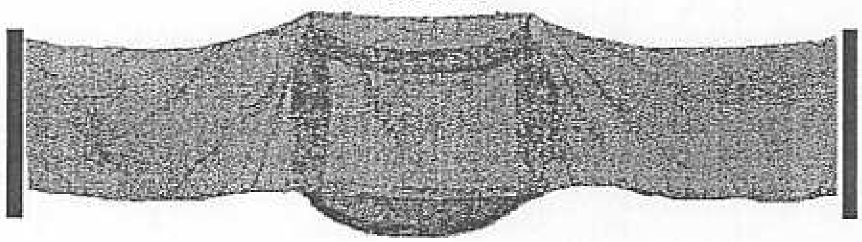
*** After setting, driving along net to check for twists and tangles may be necessary. If twists and tangles are present, may need to reset net.**

Pulling Net:

1. Slowly approach shallow float. Pull in float and anchor. Detach float and anchor before placing net into transport box.
2. One person should man the float line and the other person should man the lead line.
3. Evenly pull in the float and lead lines.
4. Disentangle any fish and place in a live well.
5. Upon reaching other end, pull in and detach deep float and anchor.

Table 4. Gear Protocols for beach seine. Included are an objective data gained, sampling design, recommended number of people, deploying and retrieving gear, and other considerations.

Gear Protocol: Beach Seine



Objective: Sample a range of fish, mostly small, fish in littoral zone of most lentic habitats.

Data Gained: The littoral zone is sampled for a range of species and sizes. (Note: large fish often escape.

Description: The seine is 44 feet from pole to pole with a 4 x 4 x 4 foot bag in the center and a 1/8 inch mesh size.

Sampling Design: The seine is fished in 33 meter sections. To maximize the effectiveness, transects are done at night.

Recommended Number of People: You will need at least two people.

Amount of Gear Set: One available net. Number of transects done were resource specific.

Prepare Site

1. Measure out a transect, usually 33 m.

2. Avoid disturbing, i.e. walking through, site.

Fishing Transect:

1. Unwrap net at 0#m and extend net perpendicular to shore making sure that bag is open in correct direction.

2. Pull seine parallel to shore with shallow person maintaining a water depth of a few inches, while the deep person should stay in 1 meter of water. Deep person should remain slightly ahead of shallow

person throughout transect and maintain a distance of at least 25 ft. between poles.

3. At end of transect, deep person should move shallower in order to meet the shallow person simultaneously at the 33 m endpoint. Note: If the net gets snagged on rocks or branches, the fish will escape so the bottom must be clear. We recommend clearing a seining path ahead of time.

4. After laying poles on ground, each person should grab a lead line and corresponding float line and evenly pull each end of the net until each reaches the bag.

5. Each person should grab a corner of the bag and decrease the size of the bag by rolling the sides down.

6. Pull all fish out of bag and place into a live well.

7. Shake netting to remove excess debris and compactly roll seine for storage.

Pro:

-Low tech, relatively easy to use
-Can produce good catches

Con:

-Requires a smooth bottom
-Biased towards small fish

Note: We are considering putting all of these gear maneuvers into an aerobic video and marketing future sampling as a form of "fitness ecotourism." By carrying the trammel net anchors, shaking down the fyke nets, and walking to set fyke nets, a wide range of muscles are worked (a little sampling humor!).

Table 5. Gear Protocols for <u>backpack electroshocker</u>. Included are an objective data gained, sampling design, recommended number of people, deploying and retrieving gear, and other considerations.

Gear Protocol: Backpack Electroshocker

<u>Objective:</u> Sample fish in both riffles and shallow pools of most stream habitats.

<u>Data Gained:</u> The stream is sampled for a range of species and sizes.

<u>Description:</u> Electrical current is used to stun fish. Their muscles are involuntarily attracted to the positive current, then they are stunned when they enter the field.

<u>Sampling Design:</u> A 25 meter reach of stream is sampled by one pass of the electrical field. Once the representative habitats at a given park have been determined, transects are randomly chosen from within a habitat type.

<u>Recommended Number of People:</u> You will need at least 2 people. Electroshocking should never be done alone for safety reasons.

<u>Amount of Gear Set:</u> 1 available unit. Number of transects done were resource specific.

<u>Prepare Transect:</u>

1. Measure transect, typically 25 meters.
2. All participants in electrofishing should be wearing appropriate gear (shock proof chest waders and rubber gloves)
3. Attach cathode and anode to proper locations.
4. Check for correct settings. ???
5. Assistant should connect battery to unit.
6. Prior to beginning the transect, test the unit on a small section of stream.

<u>Fishing Transect:</u>

1. With 1-2 assistants each carrying a net and live well (shocker can also carry net), walk diagonally from one side of stream to other side of stream while holding switch in ON position.

2. As fish surface, release button temporarily to net fish and place in live well. Proceed in this manner through remainder of transect. Note: Some fish float when stunned, others sink to the bottom, so watch carefully.
3. At end of transect, if not proceeding directly to next transect, an assistant should disconnect the battery prior to transporting the unit any distance.
4. Next transect must begin at least 10 meters past the endpoint of the previous transect.
5. Process fish after each transect.

Pro:

-Only consistent gear for stream sampling
-Can produce good catches

Con:

-Can be dangerous to fish and humans
-Only works in relatively shallow water
-Need to be able to walk safely

Note: This method can be dangerous so great care should be exercised. Keep all non-rubberized body parts out of the water. Watch for dogs and children on the bank. Also, the person running the shocker should watch others so they can stop the electricity if someone slips.

Table 6. Protocol for Fish Processing

Fish Processing

Objective: To document 90% of the fish species present in each park by sampling 5-10% of the macrohabitats representative of the resources at each park.

Data Gained: Species identification, relative abundance for each species, and individual lengths of fish.

Sampling Design: Identify and quantify all fish captured. Randomly take 20 lengths for each species at each park. Take ten fish from each species as reference specimens.

Recommended Number of People: You will need at least 1 person.

Processing:

1. Give each fish a field identification name or actual name if known. Note: Some species (like minnows) should routinely be taken to lab for identification.
2. Measure and record individual lengths and counts for 20 fish from each park and return to another live well. After twenty lengths are taken for each species, only individual counts are recorded.
3. 10 fish for each species from each park were taken as reference specimens where possible for proper identification at a later time.
4. Reference specimens were stored in labeled jars with an ethanol-water mixture or frozen in labeled bags.

Table 7. Classification of resources at each site by habitat type for Saint Gaudens NHS (SAGA). Each line is a resource. (Corresponds with Table 13 from 2002 Original Final Report.)

Park Name	Resource Name	Habitat Types: Medium Lake	Low Flow Impound./Small Pond	High Flow Impoundment	Lower Gradient Stream	Moderate Gradient Stream	Higher Gradient Stream
Saint Gaudens NHS	Blow-me-down Pond			X			
Saint Gaudens NHS	Blow-me-down Brook				X		X
Saint Gaudens NHS	Blow-me-up Brook					X	X
Saint Gaudens NHS	Farm Pond		X				

Table 8. At Saint Gaudens NHS (SAGA), for each sampling date, resource, habitat, list of gear type, time set, units of effort, and reference map location. Each line is a site. (Corresponds to Table 33 in the 2002 Original Final Report.)

Date	Resource Name	Habitat Type: Medium Lake	Low Flow Impound./Small Pond	High Flow Impoundment	Lower Gradient Stream	Moderate Gradient Stream	Higher Gradient Stream	Gear Type	Time	Units of Effort	Map #
101900	Blow-me-down Pond			X				Fyke Net	Night	3	8D
101900	Blow-me-down Pond			X				Minnow Trap	Night	15	8D
101900	Blow-me-down Pond			X				Trammel Net 1.5	Night	1	8D
001020	Blow-me-down Pond			X				Fyke Net	Day	3	8D
001020	Blow-me-down Pond			X				Minnow Trap	Day	15	8D
001020	Blow-me-down Pond			X				Trammel Net 1.5	Day	1	8D
001020	Blow-me-down Pond			X				Fyke Net	Night	3	8D
001020	Blow-me-down Pond			X				Minnow Trap	Night	15	8D
001020	Blow-me-down Pond			X				Trammel Net 1.5	Night	1	8D
001019	Blow-me-down Brook						X	Electroshocker	Day	1	8D
001020	Blow-me-down Brook						X	Electroshocker	Day	2	8D
001020	Blow-me-up Brook					X		Electroshocker	Day	8	8D
001021	Blow-me-up Brook					X		Electroshocker	Day	7	8D
001021	Farm Pond		X					Fyke Net	Day	1	8D
001021	Farm Pond		X					Minnow Trap	Day	15	8D

Table 9. For Saint Gaudens NHS (SAGA), proposed origin (native or non-native) for each species collected in freshwater fish inventory. (Corresponds to Table 63 in the 2002 Original Final Report.)

Species Present	Native	Non-native/ Introduced
Common Shiner	X	
Blacknose dace	X	
Brook Trout	X	
Brown Bullhead	X	
Creek Chub	X	
Fallfish	X	
Golden Shiner	X	
Longnose Dace	X	
Pumpkinseed	X	
Slimy Sculpin	X	
Spottail Shiner	X	
White Sucker	X	

Table 10. For Saint Gaudens NHS (SAGA), common names for fish species collected in freshwater fish inventory classified by habitat. (Corresponds to Table 73 from the 2002 Original Final Report.)

	Habitat Types					
Common Name	Small Lakes	Low Flow Impoundments	High Flow Impoundments	Lower Gradient Stream/River	Moderate Gradient Stream/River	Higher Gradient Stream/River
Alewife/Blueback Herring						
American Eel						
Banded Killifish						
Blacknose Dace			X		X	X
Bluegill						
Brassy Minnow						
Brook Trout					X	
Brown Bullhead			X			
Brown Trout						
Central Mudminnow						
Chain Pickerel						
Common Shiner			X			X
Creek Chub			X			
Cutlips Minnow						
Fallfish			X		X	
Golden Shiner			X			
Green Sunfish						

Table 10. For <u>Saint Gaudens NHS (SAGA)</u>, common names for fish species collected in freshwater fish inventory classified by habitat. (Corresponds to table 73 from the 2002 Original Final Report.)

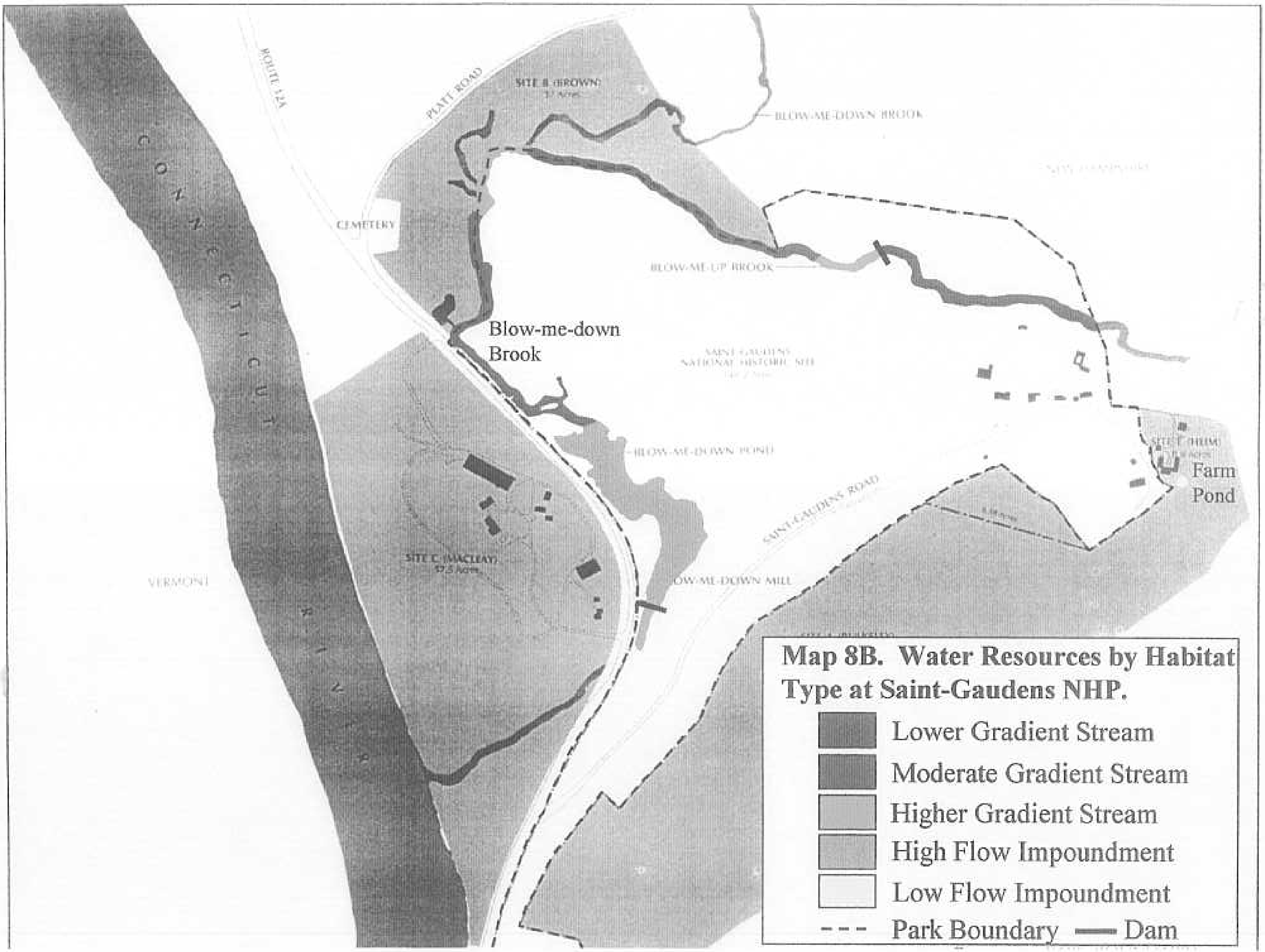
	Habitat Types					
Common Name	Small Lakes	Low Flow Impoundments	High Flow Impoundments	Lower Gradient Stream/River	Moderate Gradient Stream/River	Higher Gradient Stream/River
Johnny Darter						
Largemouth Bass						
Longnose Dace					X	X
Mummichog						
Pumpkinseed			X			X
Rainbow Trout						
Redbreast Sunfish						
Redfin Pickerel						
Rock Bass						
Rosyface Shiner						
Slimy Sculpin					X	
Smallmouth Bass						
Spottail Shiner					X	X
Tessellated Darter						
White Perch						
White Sucker			X		X	X
Yellow Perch						

Table 11. For Saint Gaudens NHS (SAGA), number of species (species richness) for fish species collected in freshwater fish inventory. (Corresponds to Table 84 in the 2002 Original Final Report.)

	Resource Name		
Species Name	Blow-me-down Brook	Blow-me- up Brook	Blow-me-down Pond
Blacknose Dace	X	X	X
Brook Trout		X	
Brown Bullhead			X
Common Shiner	X		X
Creek Chub			X
Fallfish		X	X
Golden Shiner			X
Longnose Dace	X		
Pumpkinseed			X
Slimy Sculpin		X	
Spottail Shiner	X	X	X
White Sucker	X		X

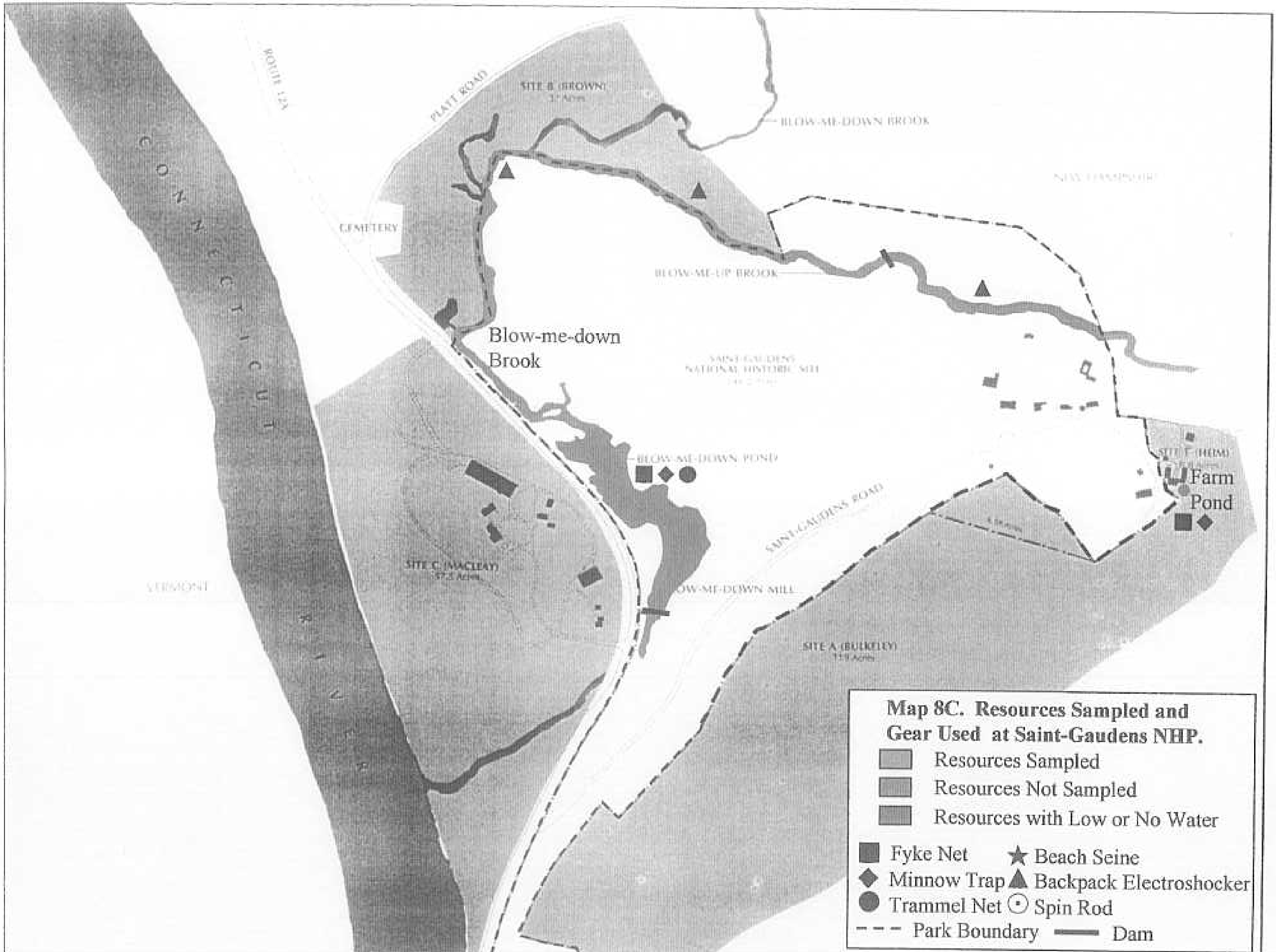
Table 12. Relative abundance of fish species by habitat type from sampling at Saint Gaudens NHS. (Corresponds to Table 94 in the 2002 Original Final Report.)

	Habitat Types					
Common Name	Small Lakes	Low Flow Impoundments	High Flow Impoundments	Lower Gradient Stream/River	Moderate Gradient Stream/River	Higher Gradient Stream/River
Alewife/Blueback Herring						
American Eel						
Banded Killifish						
Blacknose Dace			4		46	88
Bluegill						
Brassy Minnow						
Brook Trout					6	
Brown Bullhead			14			
Brown Trout						
Central Mudminnow						
Chain Pickerel						
Common Shiner			286			30
Creek Chub			47			
Cutlips Minnow						
Fallfish			1		1	
Golden Shiner			322			
Green Sunfish						
Johnny Darter						
Largemouth Bass						
Longnose Dace					1	5
Mummichog						
Pumpkinseed			77			1
Rainbow Trout						
Redbreast Sunfish						
Redfin Pickerel						
Rock Bass						
Rosyface Shiner						
Slimy Sculpin					34	
Smallmouth Bass						
Spottail Shiner					5	8
Tessellated Darter						
White Perch						
White Sucker			37		1	5
Yellow Perch						



Map 8B. Water Resources by Habitat Type at Saint-Gaudens NHP.

Lower Gradient Stream
Moderate Gradient Stream
Higher Gradient Stream
High Flow Impoundment
Low Flow Impoundment
Park Boundary — Dam


ROUTE 12A
PLATT ROAD
SITE B (BROWN)
BLOW-ME-DOWN BROOK
NEW HAMPSHIRE
CEMETERY
CONNECTICUT RIVER
BLOW-ME-UP BROOK
Blow-me-down Brook
SAINT-GAUDENS NATIONAL HISTORIC SITE
BLOW-ME-DOWN POND
SAINT-GAUDENS ROAD
SITE C (MACLEAY)
VERMONT
BLOW-ME-DOWN MILL
SITE A (BULKELEY)
SITE F (HEIM)
Farm Pond
Map 8C. Resources Sampled and Gear Used at Saint-Gaudens NHP.
Resources Sampled
Resources Not Sampled
Resources with Low or No Water
Fyke Net
Beach Seine
Minnow Trap
Backpack Electroshocker
Trammel Net
Spin Rod
Park Boundary
Dam